

1.3C Reacting Masses and Volumes
Gas Laws

Past Exam Questions (Paper 1, 2)

1. [1 mark]

What is the mass, in g, of one molecule of ethane, C_2H_6 ?

- A. 3.0×10^{-23}
- B. 5.0×10^{-23}
- C. 30
- D. 1.8×10^{25}

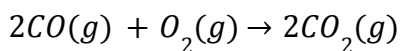
2. [1 mark]

The volume of an ideal gas at 27.0 °C is increased from 3.00 dm³ to 6.00 dm³. At what temperature, in °C, will the gas have the original pressure?

- A. 13.5
- B. 54.0
- C. 327
- D. 600

3. [1 mark]

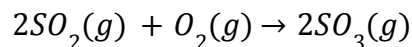
5 dm³ of carbon monoxide, CO(g), and 2 dm³ of oxygen, O₂(g), at the same temperature and pressure are mixed together. Assuming complete reaction according to the equation given, what is the maximum volume of carbon dioxide, CO₂(g), in dm³, that can be formed?



- A. 3
- B. 4
- C. 5
- D. 7

4. [1 mark]

What volume of sulfur trioxide, in cm^3 , can be prepared using 40 cm^3 sulfur dioxide and 20 cm^3 oxygen gas by the following reaction? Assume all volumes are measured at the same temperature and pressure.



- A. 20
- B. 40
- C. 60
- D. 80

5. [1 mark]

What volume of carbon dioxide, in dm^3 under standard conditions, is formed when 7.00 g of ethene (C_2H_4 , $M_r = 28.1$) undergoes complete combustion?

- A. $\frac{22.4 \times 28.1}{7.00}$
- B. $\frac{22.4 \times 7.00}{28.1}$
- C. $\frac{2 \times 22.4 \times 28.1}{7.00}$
- D. $\frac{2 \times 22.4 \times 7.00}{28.1}$

6. [1 mark]

1.0 dm^3 of an ideal gas at 100 kPa and 25°C is heated to 50°C at constant pressure. What is the new volume in dm^3 ?

- A. 0.50
- B. 0.90
- C. 1.1
- D. 2.0

7. [1 mark]

A fixed mass of gas has a certain volume at a temperature of 50°C . What temperature is required to double its volume while keeping the pressure constant?

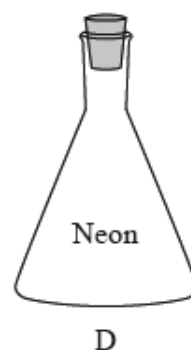
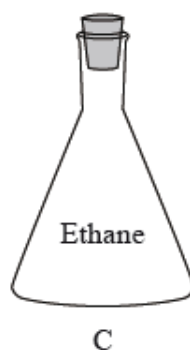
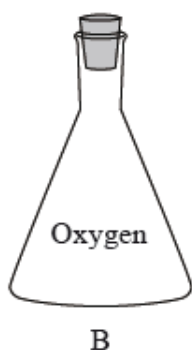
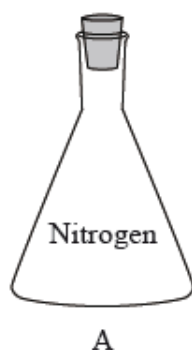
- A. 100 K
- B. 323 K

C. 373 K

D. 646 K

8. [1 mark]

Four identical containers under the same conditions are filled with gases as shown below. Which container and contents will have the highest mass?



9. [1 mark]

The volume occupied by one mole of an ideal gas at 273 K and $1.01 \times 10^5 \text{ Pa}$ is 22.4 dm^3 . What volume, in dm^3 , is occupied by 3.20 g $\text{O}_2(\text{g})$ at 273 K and $1.01 \times 10^5 \text{ Pa}$?

A. 2.24

B. 4.48

C. 22.4

D. 71.7

10. [1 mark]

What volume, in m^3 , is occupied by 2.00 mol of gas at 27°C and 2.00 atm pressure?

Assume: $1.00 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$ and $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

A. $\frac{8.31 \times 27}{1.01 \times 10^5}$

B. $\frac{2.00 \times 8.31 \times 27}{1.01 \times 10^5}$

C. $\frac{2.00 \times 8.31 \times 300}{2.00 \times 1.01 \times 10^5}$

D. $\frac{2.00 \times 8.31 \times 300}{1.01 \times 10^5}$

11. [1 mark]

What is the pressure, in Pa, if 3 mol of gas occupies 500 cm^3 at $25\text{ }^\circ\text{C}$?

Given: $R = 8.31\text{ J K}^{-1}\text{ mol}^{-1}$

$$10^{-3}\text{ m}^3 = 10^3\text{ cm}^3$$

A. $\frac{3 \times 8.31 \times 298}{500}$

B. $\frac{3 \times 8.31 \times 25}{0.0005}$

C. $\frac{3 \times 8.31 \times 25}{500}$

D. $\frac{3 \times 8.31 \times 298}{0.0005}$

12. [1 mark]

What is the pressure, in Pa, in a 100 cm^3 container containing 1.8 g of steam at a temperature of $727\text{ }^\circ\text{C}$? ($R = 8.31\text{ J K}^{-1}\text{ mol}^{-1}$)

A. $\frac{1.8 \times 8.31 \times 727}{18 \times 100}$

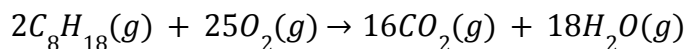
B. $\frac{18 \times 100}{1.8 \times 8.31 \times 727}$

C. $\frac{1.8 \times 8.31 \times 1000}{18 \times 10^{-4}}$

D. $\frac{1.8 \times 8.31}{1.8 \times 10^{-4} \times 1000}$

13. [1 mark]

What volume of carbon dioxide, $\text{CO}_2(\text{g})$, in dm^3 , is produced when 1 dm^3 of octane, $\text{C}_8\text{H}_{18}(\text{g})$, undergoes complete combustion?



A. 1

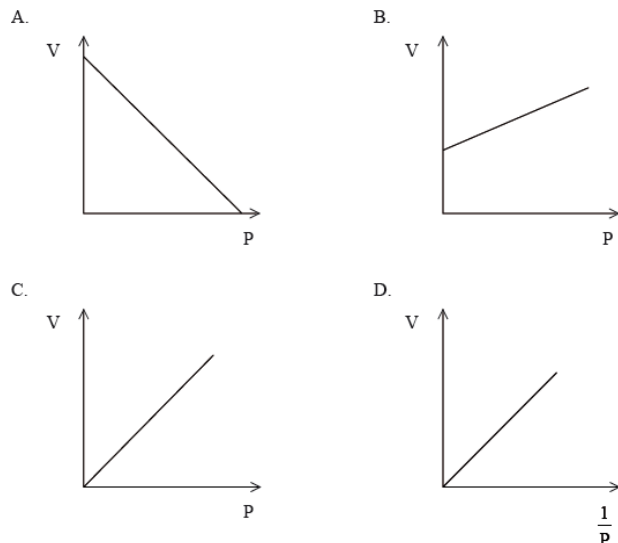
B. 4

C. 8

D. 9

14. [1 mark]

Which graph represents the relationship between volume and pressure for a fixed mass of gas at constant temperature?



15. [1 mark]

At which temperature, in K, assuming constant pressure, is the volume of a fixed mass of gas at 127 °C doubled?

- A. 200 K
- B. 254 K
- C. 400 K
- D. 800 K

16. [1 mark]

Which volumes of gases at standard temperature and pressure have the same mass as 100 cm³ of O₂?

- I. 50 cm³ of SO₂
 - II. 100 cm³ of CH₄
 - III. 100 cm³ of SiH₄
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

17. [1 mark]

At which temperature, in K, assuming constant pressure, is the volume of a fixed mass of gas at $127\text{ }^{\circ}\text{C}$ doubled?

- A. 200 K
- B. 254 K
- C. 400 K
- D. 800 K

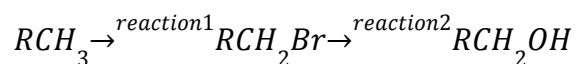
18. [1 mark]

Under which conditions does CH_4 have the same number of molecules as 100 cm^3 of O_2 at $27\text{ }^{\circ}\text{C}$ and $1.0 \times 10^5\text{ Pa}$?

	Volume / cm^3	Temperature / $^{\circ}\text{C}$	Pressure / 10^5 Pa
A.	50	54	1.0
B.	50	327	1.0
C.	100	54	2.0
D.	100	327	2.0

19. [2 marks]

Consider the following sequence of reactions.



RCH_3 is an unknown alkane in which R represents an alkyl group.

A 1.00 g gaseous sample of the alkane has a volume of 385 cm³ at standard temperature and pressure. Deduce its molecular formula.

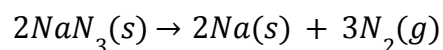
20a. [1 mark]

Airbags are an important safety feature in vehicles. Sodium azide, potassium nitrate and silicon dioxide have been used in one design of airbag.



[Source: www.hilalairbag.net]

Sodium azide, a toxic compound, undergoes the following decomposition reaction under certain conditions.

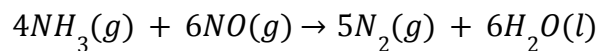


Two students looked at data in a simulated computer-based experiment to determine the volume of nitrogen generated in an airbag.

Using the simulation programme, the students entered the following data into the computer.

21. [2 marks]

Nitrogen monoxide may be removed from industrial emissions via a reaction with ammonia as shown by the equation below.



30.0 dm^3 of ammonia reacts with 30.0 dm^3 of nitrogen monoxide at 100°C . Identify which gas is in excess and by how much and calculate the volume of nitrogen produced.

.....

.....

.....

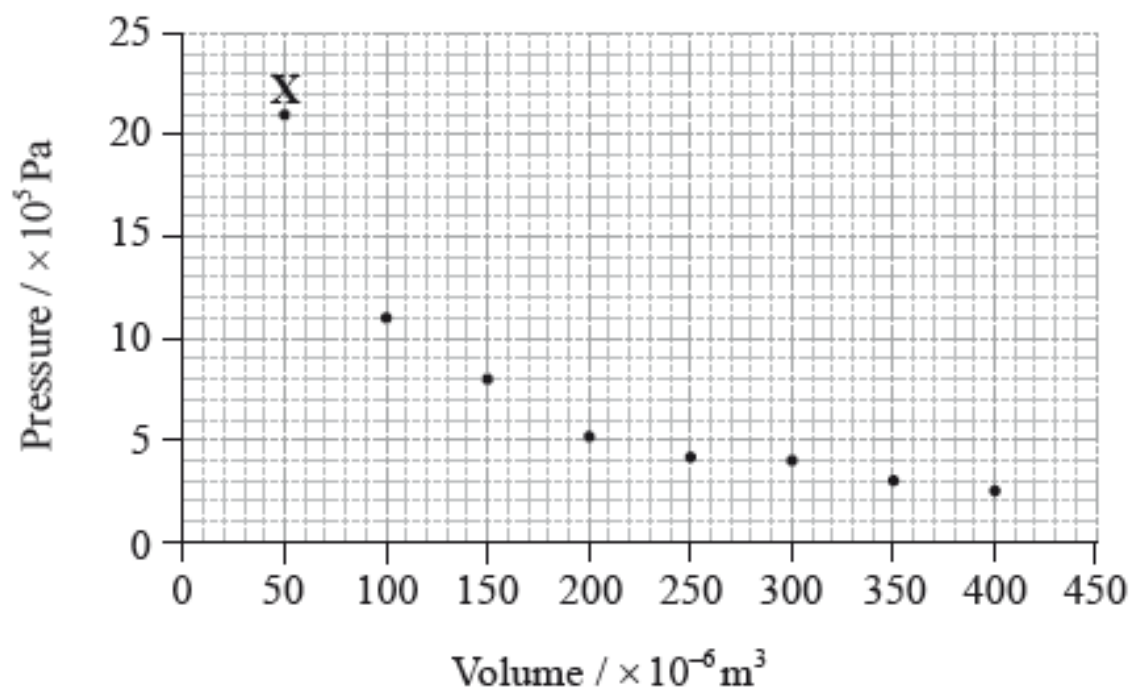
.....

.....

.....

22a. [1 mark]

The graph below shows pressure and volume data collected for a sample of carbon dioxide gas at 330 K.



Draw a best-fit curve for the data on the graph.

22b. [1 mark]

Deduce the relationship between the pressure and volume of the sample of carbon dioxide gas.

.....

.....

.....

22c. [3 marks]

Use the data point labelled **X** to determine the amount, in mol, of carbon dioxide gas in the sample.

.....

.....

.....

.....

.....

.....

23. [4 marks]

The molar mass of a volatile organic liquid, **X**, can be determined experimentally by allowing it to vaporize completely at a controlled temperature and pressure. 0.348 g of **X** was injected into a gas syringe maintained at a temperature of 90 °C and a pressure of $1.01 \times 10^5 \text{ Pa}$. Once it had reached equilibrium, the gas volume was measured as 95.0 cm^3 .

(i) Determine the amount, in mol, of **X** in the gas syringe.

(ii) Calculate the molar mass of **X**.

.....

.....

.....

24a. [1 mark]

A student added $7.40 \times 10^{-2} \text{ g}$ of magnesium ribbon to 15.0 cm^3 of 2.00 mol dm^{-3} hydrochloric acid. The hydrogen gas produced was collected using a gas syringe at 20.0°C and $1.01 \times 10^5 \text{ Pa}$.

State the equation for the reaction between magnesium and hydrochloric acid.

.....

.....

.....

24b. [3 marks]

Determine the limiting reactant.

.....

.....

.....

.....

.....

.....

24c. [3 marks]

Calculate the theoretical yield of hydrogen gas:

(i) in mol.

.....

.....

.....

(ii) in cm^3 , under the stated conditions of temperature and pressure.

.....

.....

24d. [2 marks]

The actual volume of hydrogen measured was lower than the calculated theoretical volume.
Suggest **two** reasons why the volume of hydrogen gas obtained was less.

.....

.....

.....

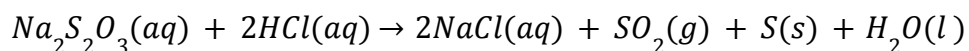
.....

.....

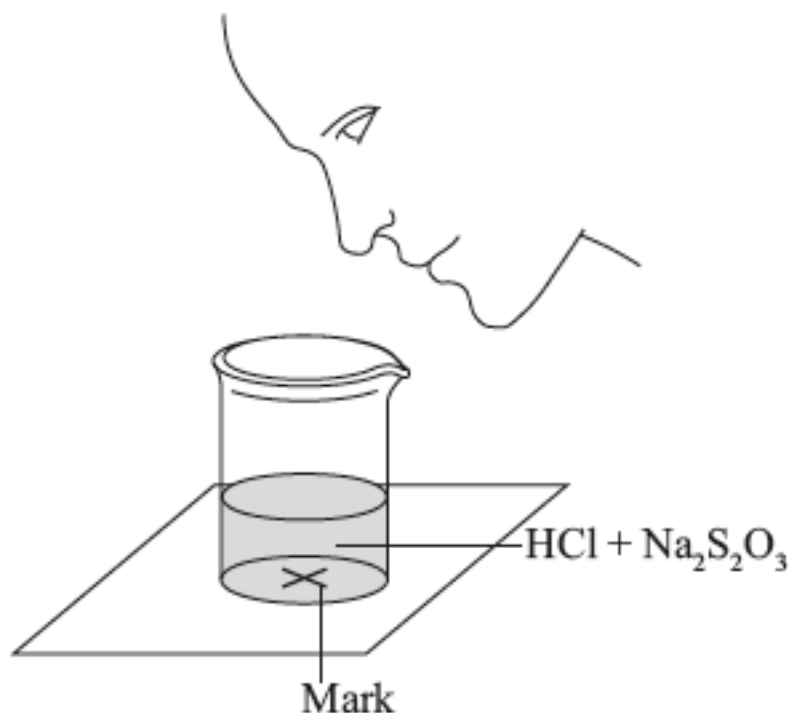
.....

25. [3 marks]

A group of students investigated the rate of the reaction between aqueous sodium thiosulfate and hydrochloric acid according to the equation below.



The two reagents were rapidly mixed together in a beaker and placed over a mark on a piece of paper. The time taken for the precipitate of sulfur to obscure the mark when viewed through the reaction mixture was recorded.



Initially they measured out 10.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid and then added 40.0 cm^3 of $0.0200 \text{ mol dm}^{-3}$ aqueous sodium thiosulfate. The mark on the paper was obscured 47 seconds after the solutions were mixed.

Another group suggested collecting the sulfur dioxide and drawing a graph of the volume of gas against time.

Calculate the volume of sulfur dioxide, in cm^3 , that the original reaction mixture would produce if it were collected at $1.00 \times 10^5 \text{ Pa}$ and 300 K.

.....

.....

.....

.....

.....

.....

Printed for INDEP SCHS FOUNDATION ACAD LIMITED

© International Baccalaureate Organization 2020

International Baccalaureate® - Baccalauréat International® - Bachillerato Internacional®